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Movements of Channel and Flathead Catfish between the Missouri River and a Tributary, Perche Creek

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Abstract.—The lower segments of tributary streams provide the only remaining backwater habitat for much of the lower Missouri River. We describe the movements of adult channel catfish *Ictalurus punctatus* between a 13-km segment of the Missouri River and a tributary, Perche Creek, that enters the river in this segment to determine the extent to which river-dwelling fish use the tributary habitats. We used mark–recapture techniques to describe movements of fish larger than 250 mm in total length between these habitats during a 22-month period. Most fish (59%) initially caught, recaptured, or both in the Missouri River moved into or out of Perche Creek, and most of these transient fish (72%) used the lower 8 km of the tributary. The tributary population was made up predominantly of resident fish (79%), which were initially caught and recaptured in Perche Creek. Channel catfish moved greater distances in the spring than in the fall and were more likely to move upstream in the spring and downstream in the fall. Fish shorter than 250 mm were more abundant in the river than in the creek and made up 45 and 35% of the catches in each area, respectively. Furthermore, of the fish longer than 280 mm, a greater proportion of the fish resident in the river (44%) than in the creek (33%) were longer than 380 mm. More fish longer than 380 mm moved from the creek to the river (44%) than from the river to the creek (26%). Thus, the tributary habitat was used most frequently by fish 280–380 mm long. Flathead catfish *Pylodictis olivaris* were much less abundant in the creek than in the river and did not provide sufficient sample sizes to evaluate movement patterns. However, based on abundances in our catches, the proportion of river flathead catfish using the creek was much lower than for channel catfish. Most of the few flathead catfish found in the creek were longer than 280 mm.

Backwater habitats are integral components of wild, large river ecosystems, yet many human alterations to large rivers reduce or eliminate the availability of these habitats to fish. Backwaters are important to fish populations for food production, feeding, and spawning, and as nursery areas. Because backwaters provide an additional habitat type to the riverine system, they are associated with increased diversity in the fish assemblages. Sylvester and Broughton (1983) found that all species captured in the main channel of the upper Mississippi River were caught in progressively greater abundance in side channels and backwaters. Ellis et al. (1979) studied three successional stages of side channels ranging from riverine to lacustrine conditions in the upper Mississippi River and found that some species are unique to each type of habitat. Backwaters also provide catfishes, buffalofishes, carp, and other river species with lentic habitats needed for spawning and nursery uses. Although no direct cause-and-effect relationship has been documented, circumstantial evidence suggests a strong relationship between decreased habitat diversity and decreased diversity in large river fish communities.

Most backwater habitats in the lower Missouri River have been eliminated by human modifications for navigation and flood control, and fish populations have declined in response (Funk and Robinson 1974; Hesse 1987). Since the 1940s, the river has become virtually devoid of backwater lakes and side channels (Berner 1951; Morris et al. 1968; Funk and Robinson 1974; Groen and Schmulbach 1978). Annual commercial fish harvests declined by 80% from 1945 to 1963 (Funk and Robinson 1974), and the assemblage of species present has changed dramatically (Pflieger and Grace 1987). Some of these changes may have been exacerbated by overharvest of some species

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(e.g., lake sturgeon *Acipenser fulvescens*); however, Pflieger and Grace (1987) have documented the major role of habitat alterations in driving these changes in the fish populations.

The most common remaining habitats that may function as backwaters for fish in the lower Missouri River are the lower sections of tributary streams. Many of these tributaries flow 5–25 km over the Missouri River floodplain before joining the Missouri River. In these segments, tributary channels are wide and deep with tree-lined banks, abundant instream cover, and relatively slow current velocities. Furthermore, the interchange between the river and tributaries is dynamic. During low flow periods, the mouths of small tributaries become completely dammed by silt deposits and then are reopened when the water level increases in the river or tributary. By understanding the function of these dynamic ecosystems and the ways in which Missouri River fish use them, fisheries managers may be able to protect and enhance the productive value of these habitats for Missouri River fish populations.

The purpose of this study was to determine the importance of one tributary, Perche Creek, to populations of channel catfish *Ictalurus punctatus* and flathead catfish *Pylodictis olivaris* in the Missouri River. Channel and flathead catfish are important commercial and sport fishes of the Missouri River and its tributaries. We assessed the value of this tributary to catfish by observing movements of fish between the river and the tributary. Our specific objectives were to describe (1) movement patterns of catfish in and between Perche Creek and the Missouri River, (2) seasonal differences in movement patterns of catfish in Perche Creek and the Missouri River, and (3) differences in movement patterns of catfish of different sizes.

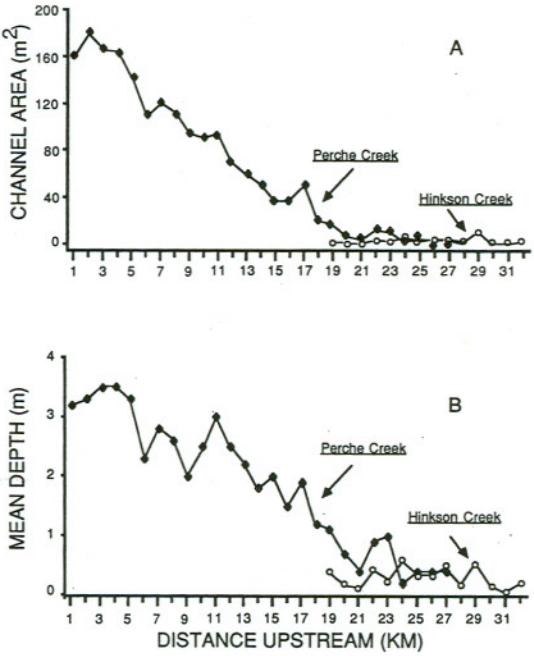

FIGURE 1.—Channel cross-sectional area (**A**) and mean water depth (**B**) measured at 1-km intervals in Perche and Hinkson creeks in July 1986.

Study Area

The study area included portions of Perche Creek, Hinkson Creek, and the Missouri River in central Missouri. Perche Creek is a south-flowing stream in Boone County that drains a watershed of 1,049 km². It enters the Missouri River 273 km above the Missouri River's confluence with the Mississippi River. Hinkson Creek is a tributary of Perche Creek that enters Perche Creek from the east about 18 km upstream from the confluence of Perche Creek and the Missouri River. We confined our sampling to the lower 27 km of Perche Creek and the lower 15 km of Hinkson Creek. The Missouri River portion of the study area was the segment extending from 5.3 km upstream to 7.6 km downstream of the mouth of Perche Creek.

Perche Creek changes from a shallow (<1 m) stream of moderate width (9–14 m) and sand–gravel bottom in the upper segment of the study area to a deeper (3–4 m) and wider (45–55 m) channel with silt–sand substrate in its lower 8 km (Figure 1). The lower 15 km of Hinkson Creek is similar to the upper segment of Perche Creek in the study area in depth, width, and substrate; however, the discharge in Hinkson Creek is not as great as in Perche Creek (Dames 1988).

Missouri River water levels and discharges were similar between the 2 years of this study. In both years, river stage increased in autumn to a maximum in October, decreased to a minimum in January, and increased to a spring maximum in May and June (Figure 2). River stage decreased in June and then increased in July of each year; there was a decline to stable levels until September.

Discharge and stage in Perche Creek were directly related to Missouri River conditions. The elevation of river stage in spring and autumn caused an increase in stage in Perche Creek due to the damming effect of the river. However, discharge was more dynamic in the creek and ranged

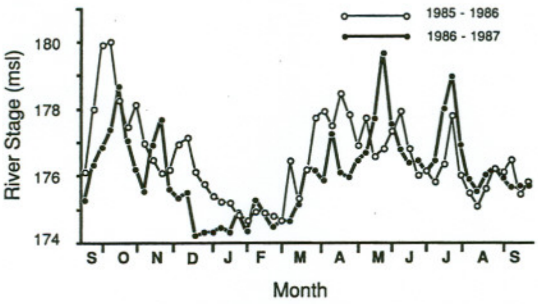

FIGURE 2.—Missouri River stages at Boonville, Missouri (river kilometer 315 from confluence with the Mississippi River) during September 1985–September 1987. Stage is measured in meters above sea level (msl).

TABLE 1.—Summary of sampling effort expended in Hinkson Creek, Perche Creek, and the Missouri River during September 1985–September 1987.

Sampling area	Netting effort (hoop-net days)	Electrofishing effort (h)
Hinkson Creek	0	20.4
Lower Perche Creek (0–8 km)[a]	807	17.2
Middle Perche Creek (8–18 km)[a]	412	1.6
Upper Perche Creek (18–27 km)[a]	0	10.2
Missouri River below Perche Creek	693	8.6
Missouri River above Perche Creek	398	3.5
All areas	2,310	61.5

[a] Distance from confluence with Missouri River.

from negligible or reversed flows as the Missouri River rose to high discharge as the river level receded after a flood. Perche Creek flow and stage conditions were relatively low and stable in winter of both years. Summer stage and discharge were lower than in spring or autumn in both years, except for a relatively brief flood in July of both years.

Methods

Data collection.—We used mark–recapture methods to monitor fish movements and to describe the populations in Perche Creek and the Missouri River. We began sampling and tagging catfish in September 1985 and continued through June 1987. We used hoop nets (2.5-cm bar mesh) baited with cheese as our primary method of capture (2,310 net-days of effort: Table 1). We used 156 hoop-net sampling sites distributed among the sampling areas designated in Table 1. Differences in sampling effort among sampling areas resulted from differences in accessibility in each area.

We supplemented hoop-net captures with electrofishing during winter months, when netting was unsuccessful, and in Hinkson and upper Perche creeks (18–27 km above the mouth), where water was too shallow for the use of hoop nets. The electrofishing effort totalled 61.5 h (Table 1). We used a boom electrofishing unit mounted on a boat 3.7 m long to collect fish in Hinkson and upper Perche creeks. We used a larger boat (4.9 m) to electrofish in other areas of Perche Creek and in the Missouri River.

All catfish were measured (total length) and weighed after capture. We tagged fish 250 mm and longer with an anchor tag and released the fish at the site of capture. We inserted the tags (model FD-68BC, Floy, Seattle, Washington) just beneath the dorsal spine with a gun applicator. Each tag was marked with a unique number, reward information, and a Missouri Department of Conservation label. We recorded all capture, release, and recapture locations on maps and determined the distance from the location to the mouth of Perche Creek with detailed maps and field measurements.

Recaptures were obtained from our own sampling (54%) and from the catches of recreational and commercial fishermen (46%). Rewards of US$2–25 were offered to encourage fishermen to return tags along with information on the date and location of recapture.

We calculated the relative stock density (RSD) of fish longer than 380 mm (RSD_{380} = 100 × [number of fish ≥380 mm]/[number of fish ≥280 mm]; Anderson and Gutreuter 1983) and 95% confidence intervals (Gustafson 1988) to summarize data on the size structure of the catfish populations sampled.

Data analysis.—We analyzed data on the distance and direction of movement of all fish that were recaptured at least once. We assigned fish to one of four movement groups based on whether the fish was captured and recaptured in Perche Creek, including Hinkson Creek and other Perche Creek tributaries (PC residents), captured and recaptured in the Missouri River (MR residents); captured in Perche Creek and recaptured in the Missouri River (PC-to-MR transients); or captured in the Missouri River and recaptured in Perche Creek (MR-to-PC transients). We treated multiple recaptures of the same fish (11% of all recaptures) as single recaptures of separate fish. The distribution of recaptures among the four movement groups was not significantly different between the first recapture of all fish and the subsequent recaptures of fish recaptured more than once (χ^2 = 0.68, P > 0.50). For some analyses, the two resident groups of fish were further divided into those that moved upstream and those that moved downstream. Fish that moved from the river to another tributary were not included in the analysis (<2% of all recaptures). The appropriate comparisons and tests were conducted by use of SAS statistical software (SAS 1985) to compare and describe the movements of these groups.

The distance that each fish moved was measured on maps by determining the midchannel distance between the capture and recapture locations. These data were analyzed with nonparametric statistical tests after preliminary tests indicated that the distances did not fit a normal distribution. We used a Kruskal–Wallis one-way nonparametric analysis of variance to identify significant effects of movement group (e.g., resident-upstream versus resident-downstream and PC-to-MR versus MR-to-PC) on movement distance. When significant movement group effects were detected, we used Dunn's procedure for multiple comparisons to determine which of the six movement groups differed with respect to distance (Daniel 1978). We set the experimentwise significance level at 0.15, which resulted in a comparisonwise significance level of 0.005 for each of the 30 possible comparisons. We also compared seasonal differences between upstream and downstream movement groups with observations made in autumn 1985 and spring 1986. We used the same experimentwise significance level (0.15) to keep the probability of type-I error consistent, but because we separated the analyses of Perche Creek residents, Missouri River residents, and transients, the comparisonwise level of significance for each of the 12 possible comparisons in each analysis was 0.013.

Results

Channel Catfish

We captured 7,539 channel catfish, tagged 4,165 of these, and recaptured 824 (20%; Table 2). The sampling gear caught 446 (54%) of the recaptures, and the remainder were caught by fishermen. Over 70% of all channel catfish captured were caught in Perche Creek and its tributaries. Although the regression of the distance moved between capture and recapture and the number of days between captures was significant ($r^2 = 0.025$, $P < 0.001$), the low slope (0.038 km/d) and r^2 value indicate that the number of days between captures explained little of the variance in the distances between locations. Because of these results, we used the total distance moved between captures for movement comparisons.

Movements in and among habitats.—Among the recaptured fish that were captured, recaptured, or both in Perche Creek, 79% were residents (Table 3). Residents moving upstream made up 47% of the fish in Perche Creek and moved significantly farther than residents moving downstream ($P < 0.005$; Figure 3). The maximum distance moved by a Perche Creek-resident fish was 56 km upstream. The distances of transient movements from the Missouri River to Perche Creek (MR to PC) were greater than for resident movements upstream, and movements from PC to MR were greater distances than resident movements downstream ($P < 0.005$; Figure 3). The maximum distance moved by a PC-to-MR transient was 374 km, whereas the maximum for an MR-to-PC transient was 54 km; however, the median distances moved were not significantly different between the two transient subpopulations.

TABLE 2.—Summary of channel catfish (CCF) and flathead catfish (FHC) catches from Hinkson Creek, Perche Creek, and the Missouri River during September 1985–September 1987. Fish at least 250 mm in total length were tagged with a Floy anchor tag.

	Number of fish							
	Caught		<250 mm		Tagged		Recaptured	
Sampling area	CCF	FHC	CCF	FHC	CCF	FHC	CCF	FHC
Hinkson Creek	95	1	3	0	54	0	38	1
Lower Perche Creek (0–8 km)[a]	3,488	27	1,000	2	2,207	24	281	1
Middle Perche Creek (8–18 km)[a]	1,637	25	652	3	797	21	188	1
Upper Perche Creek (18–27 km)[a]	124	6	3	3	28	3	93	0
Missouri River below Perche Creek	1,557	289	720	182	741	101	96	6
Missouri River above Perche Creek	604	83	172	47	338	31	94	5
Other tributaries	34	2	0	0	0	0	34	2
All areas	7,539	433	2,550	237	4,165	180	824	16

[a] Distance from confluence with Missouri River.

TABLE 3.—Distribution of resident (within tributary or river) and transient (between tributary and river) movements by channel catfish. Data are percentages based on observations of tagged fish that were recaptured at least once.

Sampling area	N	Resident			Transient	
		No movement	Upstream	Downstream	PC to MR	MR to PC
Perche Creek (PC)	701	5	47	27	14	7
Missouri River (MR)	256	3	18	20	39	20

The transient channel catfish made up a larger proportion (59%) of the Missouri River sample than of the Perche Creek sample (Table 3). The number of Missouri River residents moving upstream and downstream was similar (Table 3), but the distances of upstream movements were greater than the distances of downstream movements ($P < 0.005$; Figure 3). The maximum distance moved by a Missouri River resident was 469 km upstream in only 72 d. The distances of movements from PC to MR were greater than the distances of resident movements downstream ($P < 0.005$), whereas the distances of MR-to-PC movements did not differ significantly from those of the resident movements upstream (Figure 3).

In Perche Creek, transient catfish were caught most frequently in the lower reaches (Figure 4). Ninety-five percent of all transient fish were captured or recaptured within 20 km of the mouth of Perche Creek. The lower 8 km of Perche Creek yielded over 72% of the transient channel catfish, and over half of the transients were collected in the lower 4 km.

Seasonal movements.—We used the mark–recapture data to describe and compare seasonal movements of channel catfish. We distinguished seasons according to water temperatures as follows (Dames 1988): autumn, September 15–November 30; winter, December 1–February 28; spring, March 1–June 30; and summer, July 1–September 24. Sample sizes in these comparisons were reduced because only fish that were tagged and recaptured in the same season were included. Sufficient sample sizes were obtained in fall 1985 and spring 1986. The numbers of fish tagged and recaptured in the same season during the second year of the study were too small to make meaningful comparisons. Therefore, descriptions of seasonal movement behavior are limited to data collected during the first year of the study.

Movements of Perche Creek residents showed seasonal differences in the distances and directions moved. The distances of upstream movements were greater than the distances of downstream movements in autumn ($P < 0.013$), but in spring, the distances of upstream and downstream movements were similar (Figure 5A). In spring, the distances of upstream and downstream movements were greater than the distances of autumnal upstream and downstream movements, respectively ($P < 0.013$). In autumn, about 59% of the fish made downstream movements and 35% made upstream movements (Table 4). This pattern was reversed in the spring: about 55% moved up-

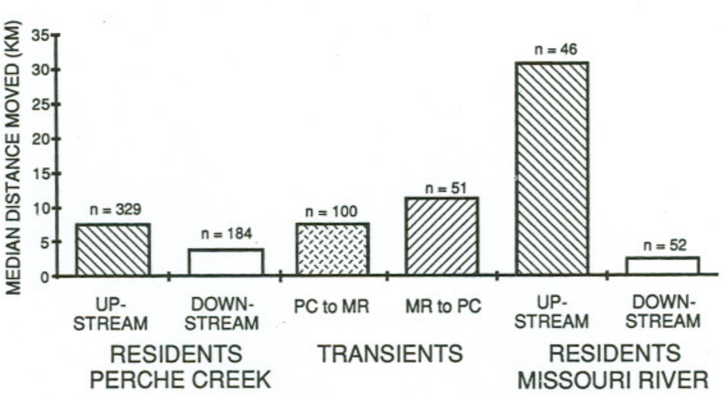

FIGURE 3.—Median distance traveled by resident and transient channel catfish between successive captures in Perche Creek (PC) and the Missouri River (MR) during September 1985–September 1987. The number of observations is given above each bar.

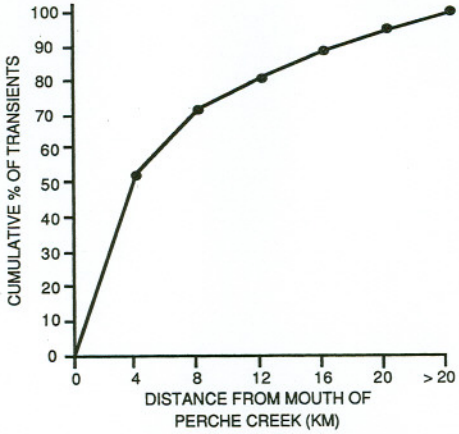

FIGURE 4.—Location of captures or recaptures of transient channel catfish in Perche Creek.

stream, and 33% moved downstream (Table 4). These proportions were significantly different between the seasons (χ^2, $P < 0.01$). Six of the nine fish tagged and recaptured during winter 1985–1986 made no movements.

Missouri River residents showed similar patterns in their seasonal movements. The fish moved greater distances in spring than in autumn, regardless of direction, whereas within each season, the fish moved similar distances upstream and downstream (Figure 5B). In autumn, 73% of the fish moved downstream, and 27% moved upstream; the trend was reversed in spring ($P < 0.06$; Table 4). No movement was detected for the three channel catfish tagged and recaptured during winter 1986–1987.

The transient channel catfish also showed seasonal differences in their movement patterns. The fish moving from PC to MR moved greater distances in spring than in autumn ($P < 0.013$; Figure 5C). In autumn, all of the transient fish moved from PC to MR, whereas in spring, 50% moved from PC to MR, and 50% moved from MR to PC (Table 4).

Population characteristics.—The Missouri River-resident and the PC-to-MR-transient movement groups were made up of a greater proportion of large fish (>380 mm) than those in the Perche Creek-resident and the MR-to-PC-transient movement groups (Table 5). These differences were reflected in the size structure of the total sample (i.e., residents and transients, recaptured and nonrecaptured fish combined) in Perche Creek and in the Missouri River (Table 5). The catch reported by fishermen was selective for larger channel catfish in both habitats; however, a greater proportion of large fish was caught in the Missouri River than in Perche Creek (Table 5). In addition, the proportion of fish less than 250 mm long taken in our Missouri River samples (residents and transients combined) was greater than the proportion taken in Perche Creek samples (Table 2). Forty-five percent of the river sample was less than 250 mm long, whereas 35% of the sample in the creek was in this size-group.

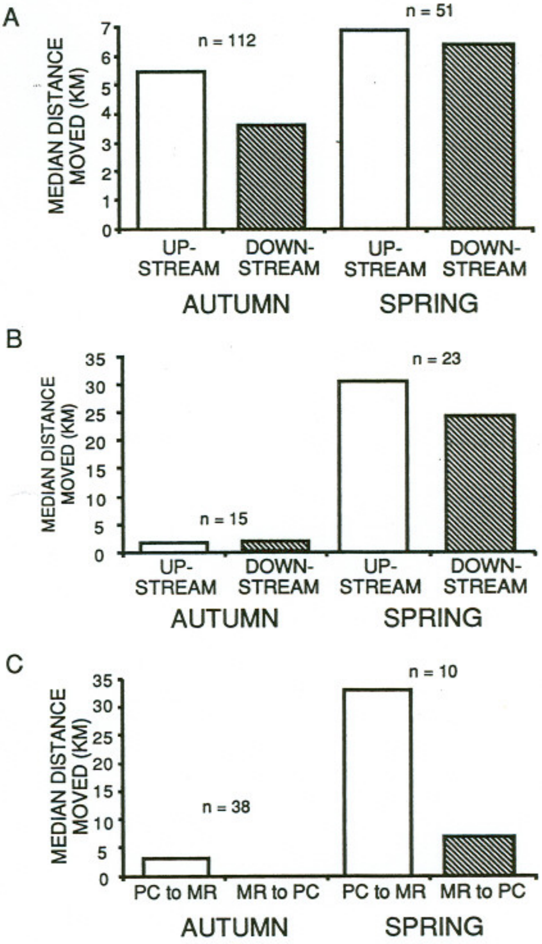

FIGURE 5.—Median distances moved by channel catfish between successive captures in Perche Creek (PC) and the Missouri River (MR) in autumn 1985 and spring 1986. (**A**) Perche Creek residents; (**B**) Missouri River residents; (**C**) transients (n denotes sample size).

Flathead Catfish

We captured 433 flathead catfish during the study (Table 2). Only 180 were tagged, of which 16 were recaptured. Fourteen of these recaptured fish were caught by fishermen, and nearly 86% were captured in the Missouri River. Because so

TABLE 4.—Seasonal comparison of the distribution of resident (within tributary or river) and transient (between tributary and river) movements by channel catfish. Movement data are percentages based on observations of tagged fish that were recaptured at least once.

Direction or sample size	Fall 1985	Spring 1986
Perche Creek (PC) residents		
No movement	6%	12%
Upstream	35%	55%
Downstream	59%	33%
N	112	51
Missouri River (MR) residents		
No movement	0%	9%
Upstream	27%	56%
Downstream	73%	35%
N	15	23
Transients		
PC to MR	100%	50%
MR to PC	0%	50%
N	38	10

TABLE 5.—Relative stock density (RSD_{380} = 100 × [number of fish ≥380 mm]/[number of fish ≥280 mm]) of channel catfish movement groups and samples in the Missouri River and Perche Creek during September 1985–September 1987. Values in parentheses are 95% confidence intervals for the RSD_{380} estimates. Sample sizes are the number of fish at least 280 mm in total length. Study samples are all fish captured and tagged without respect to whether they were recaptured. Fisherman samples are all fish caught and reported by fishermen; for these, we used the length measurement taken during our most recent capture or recapture preceding the fisherman's catch.

Group	*N*	RSD_{380}
Movement group		
Perche Creek (PC) residents	348	33 (±5)
Missouri River (MR) residents	73	44 (±12)
PC–MR transients	70	44 (±13)
MR–PC transients	35	26 (±17)
Sample		
Perche Creek		
Study sample	2,030	26 (±2)
Fisherman sample	202	41 (±7)
Missouri River		
Study sample	735	36 (±4)
Fisherman sample	84	57 (±12)

few fish were recaptured during the study, none of the movement analyses could be completed for this species. The maximum distance moved by a flathead catfish was 313 km in 76 d. Another flathead catfish moved 100 km, and the remaining fish moved less than 14 km. Most of the flathead catfish captured in Perche Creek were longer than 250 mm (86%), yet only 38% of the Missouri River catch was this large (Table 2).

Discussion

Tributaries provide important habitats for Missouri River channel catfish populations. Over 2 years, 18% of recaptured channel catfish made transient movements between Perche Creek and the Missouri River, and an additional 2% of recaptured catfish moved into other tributaries along the Missouri River. Hesse et al. (1979a) found that channel catfish from the middle Missouri River moved into tributary streams. They captured, tagged, and released channel catfish in the Missouri River near the mouth of the Little Nemaha River, Nebraska. Over 41% of all recaptures were taken in the Little Nemaha and other tributaries. In a similar study, Hesse et al. (1979b) found that 26% of the channel catfish tagged and released in the Missouri River and later recaptured had moved into the Niobrara River, Nebraska. Funk (1955), Hubley (1963), and Humphries (1965) also reported movements of channel catfish into tributary streams.

We found relatively few flathead catfish in Perche Creek, and most of these were longer than 250 mm. This could be the result of sampling inefficiencies. The slower current velocities in Perche Creek may reduce the effectiveness of baited hoop nets for capturing flathead catfish, although this did not seem to affect the capture of channel catfish. It is more likely that Missouri River flathead catfish rarely use tributaries like Perche Creek. Of the few recaptures that we recorded, 63% were captured and recaptured in the Missouri River. Furthermore, the size structures of river and creek samples suggest that small flathead catfish in particular avoid Perche Creek and prefer the Missouri River. Thus, there appears to be little exchange between the river and creek flathead catfish populations.

The channel catfish populations in Perche Creek appeared to be composed primarily of resident fish that remain in the tributary, whereas the Missouri River population was largely composed of transient fish. The results of our mark–recapture study indicated that 79% of the movements in Perche Creek were resident movements, whereas in the Missouri River, 59% of the observed movements were transient movements between the creek and the river. Although we examined the movements of channel catfish in only one tributary, channel catfish behavior in other tributaries of a similar size probably is similar to that observed in Perche Creek.

Resident movements in Perche Creek were predominantly in an upstream direction, and the distances of upstream movements were greater than the distances of downstream movements. The proportions of upstream and downstream movements we recorded in Perche Creek may be biased due to the sampling pattern used. Our sampling may have detected upstream-moving fish more frequently than downstream-moving fish because fish were not tagged high in the Perche Creek watershed, yet anglers caught fish that had moved upstream from our sampling area. Also, the differences in the proportions of upstream and downstream movements in Perche Creek were reduced when we combined resident movements upstream with the Missouri River to Perche Creek transient movements (54%) and resident movements downstream with the Perche Creek to Missouri River transient movements (41%). When we further disregarded recaptures from above the tagging area, the proportions of upstream and downstream movements became even more similar, 48 and 46%, respectively.

In the Missouri River, resident movements upstream were much longer than resident movements downstream; however, upstream and downstream movements occurred with similar frequencies. In some earlier studies, it was reported that channel catfish tended to move downstream (Wickliff 1933, 1938; Funk 1955; Hubley 1963; Welker 1967), and other investigators reported that upstream movements predominated (McCammon 1956; Muncy 1957; Mayhew 1971). The reasons for these discrepancies are not clear; however, they may be related to stream size, current velocity, presence of dams, use of displaced fish, and the time of tagging and recovery.

Channel catfish in our study often moved considerable distances, especially in upstream directions. These data and data from a related study (Dames 1988) demonstrated that channel catfish can move long distances in a relatively short time. Similarly, Funk (1955) found that 63% of the channel catfish he tagged and recaptured had moved 1.6 km or more. In the upper Mississippi River, 73% of recaptured channel catfish were recovered within a 40-km radius of their tagging site (Hubley 1963). Most channel catfish movements in the Sacramento River valley of California were less than 48 km (McCammon and LaFaunce 1961), whereas the distances of most channel catfish movements in the Des Moines River, Iowa, were less than 10 km (Harrison 1953; Muncy 1957; Mayhew 1971). Movement distances up to 342 km have been reported previously (Hubley 1963). We recorded a maximum distance of 374 km.

Both the distance and the direction of movements changed seasonally. Our comparison of seasonal data was limited to spring and autumn, largely due to improved capture success in these seasons in comparison with those in winter and summer. Because we used a passive capture method, the difference in seasonal catch rates suggests that movement activity was greatest during the spring and autumn. Spring movements were usually upstream, whereas movements were generally downstream in autumn. Movements from the Missouri River into Perche Creek were more frequent in spring than in autumn. McCammon (1956) and Duncan and Myers (1978) reported similar patterns in the seasonal movements of channel catfish. Stang and Nickum (1985) found that little movement occurred during the autumn–winter period relative to that during the spring–summer period. Channel catfish movements into a tributary from the Savannah River occurred in the spring, but movements back to the Savannah River occurred in late spring and early summer (Humphries 1965). Grace (1985) reported that flathead catfish moved up the Missouri River and that channel catfish moved primarily into tributaries during the spring.

The size structures of movement groups and the entire populations in the two sampling areas (Perche Creek and Missouri River) suggested that channel catfish of certain sizes were more likely to move into or out of a tributary and that other sizes were more likely to remain resident. In particular, small (<250 mm) channel and flathead catfish were more common in the Missouri River than in Perche Creek. This size range corresponds to fish age 3 and younger for both species in this region (Dames 1988; J. W. Robinson, unpublished data). Channel catfish in an intermediate size range (280–380 mm, age 4–6) made up a large proportion of those fish that moved from the Missouri River to Perche Creek, as indicated by the low RSD_{380} for this transient group (Table 5), and fish in this size range were more likely to stay in Perche Creek than larger fish (>380 mm).

A greater proportion of fish longer than 380 mm moved from the creek to the river and were resident in the river. This suggested that larger fish had a greater preference for the river than fish in the intermediate size range. An alternative explanation for the greater proportion of large fish in the river than in the creek is that the harvest was more selective in the creek. However, the size structure of the catch reported by fishermen shows that anglers in the creek caught more large fish (>380 mm) than intermediate fish (280–380 mm), but a smaller proportion of their catch was in the large size range than that of the river fishermen. Furthermore, fishing in the creek is restricted to recreational fishing with no size limit on harvested fish; recreational and commercial fishing is allowed in the river, and commercial fishermen must obey a 380-mm minimum-length limit. The fishermen's catch data and regulations both suggest that the river fishery was more selective for large fish than the creek fishery. The difference in the size structure of resident creek and resident river movement groups was probably due to differential movement between these habitats by different size-groups of fish.

Our designation of fish as residents or transients was based on 2 years of observation. Fish may be resident for a period of several years and then move to a different habitat at another stage in their life history. Our designations may be incorrect for a particular fish in the long term; however, these designations should be representative of the probability of residency or transience for the river and creek populations. These data suggest that channel catfish are more likely to remain in the river until they reach their third or fourth year. Between their third and sixth years, they have a greater tendency to move into and remain in the tributary. It is during these years that they reach sexual maturity (Ragland and Robinson 1972). Adult fish in the creek that are longer than 380 mm are more likely to move back to the river and to remain there throughout the rest of their lives, except for occasional movements into tributaries. The occasional movements that adult fish do make into tributaries seem most likely to occur in the spring, perhaps in response to rising river levels and when the fish are in search of spawning habitat, prey, or refuge from high discharge. The transition from river to tributary for channel catfish 280–380 mm long may correspond to a shift from a diet of benthic invertebrates to a more piscivorous diet. Bailey and Harrison (1948) and Russell (1965) both found that river-dwelling channel catfish longer than 300 mm were more piscivorous than smaller fish and that the major prey of these piscivorous catfish was gizzard shad *Dorosoma cepedianum.* Typically, young gizzard shad are abundant in the tributaries we studied and are uncommon in the Missouri River (Robinson, unpublished data).

Although our data on flathead catfish are not as conclusive as our data on channel catfish, the major difference in their movement patterns appeared to be that young flathead catfish showed stronger avoidance of the tributary habitat, and adult flathead catfish were less likely to be in the tributary or to move between the river and the tributary than adult channel catfish. Thus, the tributaries probably have greater importance to channel catfish populations than flathead catfish populations in the Missouri River.

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